GARIMA SINGH

Jet Propulsion Laboratory
M/S 183-901, 4800 Oak Grove Drive,
Pasadena - 91109
California, USA

https://science.jpl.nasa.gov/projects/SDC/
www.naoj.org/Projects/SCEXAO/
Email: garima.singh@jpl.nasa.gov
Tel: +1 (818) 354-2813
DOB: 12 June 1987
Nationality: Indian

RESEARCH INTEREST

- Ground and space-based astronomical instrumentation
- High contrast imaging of Exoplanets and disks
- Optical/Infrared Extreme Adaptive Optics
- Speckle suppression & coronagraphic wavefront control techniques
- Terrestrial-like exoplanet direct imaging in the habitable zone
- Post-processing techniques

EDUCATION

Ph.D., *High Honors*, **Astronomy & Astrophysics (Instrumentation)**
Laboratoire d'études spatiales et d'instrumentation en astrophysique (LESIA)
Observatoire de Paris-Meudon, *France* *October 2012 - September 2015*

Dissertation: Low-order wavefront control and calibration for phase mask coronagraphs.

Thesis Advisors: Prof. Olivier Guyon, Dr. Daniel Rouan, Dr. Pierre Baudoz

M.Tech., *Honors*, **Astronomy & Astrophysics** *July 2008 - September 2010*
Université de Paris XI Sud, *France*

Domain: Astronomical & Space-based System Engineering

B.Tech., *First Division*, **Information Technology** *July 2004 - May 2008*
College of Engineering Roorkee, *India*

RESEARCH EXPERIENCE

NASA Postdoctoral Program Fellow *November 2015 - present*
Jet Propulsion Laboratory, Pasadena, *USA*

- Currently involved in the development of static Zernike wavefront sensor downstream Palm 3K Extreme adaptive optics instrument at Palomar 200 inch telescope.
- Studying the ways to control low-order wavefront aberrations upstream the Stellar Double Coronagraph (SDC) bench. Studying/developing an algorithm to calibrate PSF near the coronagraphic inner working angle using the wavefront sensor telemetry.
- Involved in the COMPACT coronagraph project at JPL.

Subaru Research Intern *October 2012 - September 2015*
Subaru Telescope, Hawaii, *USA*

I have designed, developed, build and programmed a Lyot-based low order wavefront sensor (LLOWFS, Singh et al. PASP 2014) for Subaru Coronagraphic Extreme Adaptive Optics System (SCExAO) at the Subaru Telescope. LLOWFS is a linear wavefront reconstructor which measures the low-order wavefront aberrations occurring upstream of a coronagraph. This sensor is essentially designed to stabilize the pointing errors and other low-order aberrations for non-reflective phase mask coronagraphs. On-sky result has demonstrated correction of 10 Zernike modes, with a closed-loop pointing residuals of 0.15 mas for tip-tilt with a vector vortex coronagraph (Singh et al. PASP 2015).

Advisor: Prof. Olivier Guyon, Dr. Pierre Baudoz

Research Associate on a Temporary Contract *July-September 2012*
LESIA, Observatoire de Paris-Meudon, *France*
Development of a high performance coronagraph for SCExAO at the Subaru Telescope.
Advisor: Prof. Pierre Baudoz

Adaptive Optics System Developer *July 2011 - January 2012*
Inter-University center for Astronomy & Astrophysics (IUCAA), Pune, *India*
Design and setting up of a prototype of Robo Adaptive Optics (Robo-AO) bench for IUCAA's Girawali Observatory (IGO), Pune.
Advisor: Prof. A.N. Ramprakash

Research Associate *January - June 2011*
Aryabhatta Research Institute of Observational Sciences (ARIES), Nainital, *India*
Analysis and documentation of the prototype of an adaptive optics system for ARIES optical laboratory.
Advisor: Prof. Amitesh Omar

Subaru Research Intern *April - September 2010*
Subaru Telescope, Hawaii, *USA*
Master Thesis: Focus tracking of the laser guide star using the guide star acquisition unit of the Subaru Telescope's adaptive optics system (LGSAO188).
Developed a technique to track the focus of the Subaru's laser guide star acquisition system. The position of the laser projected at 90 km is the time dependent function of the elevation. With the change in the laser position with respect to the elevation, laser spot becomes defocused which in turn is sensed as a focus aberration in the wavefront during adaptive optics closed-loop operation. I have developed an IDL control algorithm to correct in real-time, the defocus of the laser spot caused by the elevation change.
Advisor: Dr. Yutaka Hayano

Summer Project *June - July 2009*
Galaxies Etoiles Physique et Instrumentation (GEPI), Observatoire de Paris-Meudon, *France*
Spectroscopic analysis & determination of the mass ratio of HD 61273: a semi-detached binary system with an accretion disk (Tool: FDBinary, Programming language: IDL).
Advisor: Dr. Frédéric Royer

Summer Project *May 2009*
Université de Paris XI Sud, *France*
Analysis of impulse response of the James webb space telescope for reconstruction of high resolution images in Matlab.

Summer Project *January - May 2008*
College of Engineering Roorkee, *India*
Voting System developed in C: to allow voters to choose between options to select different plan of actions, often in an election where candidates are selected for public office.

OBSERVING EXPERIENCE

SCExAO On-Sky Time *November 2012 - October 2015*
Subaru Telescope (8.2 meters), MaunaKea Observatory

28 Engineering and 16 Science nights with Subaru Telescope AO188, SCExAO and high contrast instrument for next generation adaptive optics (HICIAO).

SDC On-Sky Time *November 2015*
Palomar's Hale Telescope (5.1 meters), 2 Science nights with P3K, SDC and PHARO instrument.

RESEARCH AWARDS

NASA Postdoctoral Program (NPP) Fellowship — *November 2015 - present*
French Government scholarship **"Conseil Région île-de-France"** — *2008-2010*

TECHNICAL SKILLS

Programming/Software

- iPython, C, IDL, Java
- Solidworks (Mechanical designs), ZEMAX (Optical Design)

ASTRONOMY OUTREACH

- Involved in the astronomy discussions and public guidance as a member of **"Amateur Astronomers Association Delhi (AAAD)"**, India
- **"Journey through the Universe"** educator, a public education program held annualy by GEMINI Observatory in Hilo, Hawaii.
- An active volunteer for astronomy talks, activities and discussions with public during **"Astroday"**, an annual event organized by Mauna Kea Astronomy Outreach Committee, Hawaii.
- Member of **"Young Astronomers Journal Club"** at Subaru Telescope and actively participate in the presentations and discussions about weekly discovery in Astronomy.

LANGUAGES KNOWN

English, French (DELF, "Diplôme d'etudes en langue Française" level B1 holder), Hindi, Punjabi

REFERENCES

Prof. Olivier Guyon
Steward Observatory
University of Arizona
933 N Cherry Ave.
Tucson AZ 85721
Tel: +1 818 293 8826
guyon@naoj.org

Dr. Pierre Baudoz
LESIA
Observatory of Paris-Meudon
5 Place Jules Janssen
92195 Meudon Cedex
Tel: +33 1 45 07 79 11
pierre.baudoz@obspm.fr

Prof. Gérard Rousset
LESIA
Observatory of Paris-Meudon
5 Place Jules Janssen
92195 Meudon Cedex
Tel: +33 1 45 07 75 49
gerard.rousset@obspm.fr

PROFESSIONAL DEVELOPMENT

Summer Schools

- Sagan Workshop — *21-25 July 2014*
  California Institute of Technology, Pasadena, CA
- Search for Life beyond the Solar System (Exoplanets, Biosignatures & Instruments) *14-16 March 2014*
  Biosphere2, University of Arizona, Tucson
- Astronomy & Astrophysics — *11-16 August 2013*
  Dunlap Institute for Astronomy, University of Toronto, Canada
- Adaptive Optics — *4-9 August 2013*
  Center for Adaptive Optics, University of Santa Cruz, California.

PRESENTATIONS

Low-order wavefront control and calibration for phase mask coronagraphs. — *September 2015*
(Invited talk) *STScI Star and Planet Formation Seminar Series, Baltimore*

Lyot-based low-order wavefront sensor: Implementation on the Subaru Coronagraphic Extreme Adaptive Optics System and its Laboratory Performance. *July 2014*
(Poster & POP) *Sagan Workshop, California Institute of Technology, Pasadena*

Lyot-based low-order wavefront sensor: Implementation on the Subaru Coronagraphic Extreme Adaptive Optics System. *June 2014*
(Poster) *SPIE Astronomical Telescopes & Instrumentation, Montreal, Canada*

Lyot-based low-order wavefront sensor for phase mask coronagraphs. *March 2014*
(Poster) *Search for life beyond the solar system: Exoplanets, Biosignatures & Instruments conference, Arizona*

Low-order aberrations control and PSF calibration on SCExAO *February 2014*
(Invited talk) LOWFS & PSF for Exoplanets meeting, *Jet Propulsion Laboratory, Pasadena*

Phase mask ultra fine pointing control system. *December 2013*
(Poster) *5th Subaru International Conference: Exoplanet & disks, Kona, Hawaii*

Phase mask coronagraphic low-order wavefront sensor. *May 2013*
(Poster) *AO4ELT3 conference, Florence, Italy*

PUBLICATIONS

Peer-reviewed Papers

- "Lyot-based low order wavefront sensor for phase mask coronagraphs: Principle, Simulations and Laboratory Experiments"
  Singh, G., Martinache, F., Baudoz, P., Guyon, O., Matsuo, T., Jovanovic N., Clergeon, C. *Publications of the Astronomical Society of the Pacific*, vol. 126, pp. 586-594, June 2014.
- "On-Sky speckle nulling demonstration at small angular separation with SCExAO"
  Martinache, F., Guyon, O., Jovanovic, N., Clergeon, C., **Singh, G.**, Kudo, T., Currie, T., Thalmann, C., McElwain, M., Tamura, M. *Publications of the Astronomical Society of the Pacific*, vol. 126, pp. 565-572, June 2014.
- "On-Sky Demonstration of Low-Order Wavefront Sensing and Control with Focal Plane Phase Mask Coronagraphs"
  Singh, G., Lozi, J., Guyon, O., Baudoz, P., Jovanovic N., Martinache, F., Kudo, T., Serabyn, E., & Kuhn, J. *Publications of the Astronomical Society of the Pacific*, Volume 127, issue 955, pp.857-869, 2015.
- "The Subaru Coronagraphic Extreme Adaptive Optics System: Enabling High-Contrast Imaging on Solar-System Scales"
  Jovanovic, N., Martinache, F., Guyon, O., Clergeon, C., **Singh, G.**, Kudo, T., et al. *Publications of the Astronomical Society of the Pacific*, Volume 127, issue 955, pp.890-910, 2015.

Conference Proceedings

- "Lyot-based Low Order Wavefront Sensor: Implementation on the Subaru Coronagraphic Extreme Adaptive Optics System and its Laboratory Performance"
  Singh, G., Guyon, O., Baudoz, P., Jovanovic, N., Martinache, F., Kudo T., Serabyn, E., Kuhn,J. G. *Proc. SPIE 9148, Adaptive Optics Systems IV, 914848, doi:10.1117/12.2057211 (August 2014).*
- "Development and recent results from the Subaru coronagraphic extreme adaptive optics system"
  N. Jovanovic, O. Guyon, F. Martinache, C. Clergeon, **G. Singh**, T. Kudo, K. Newman, J. Kuhn, E. Serabyn, B. Norris, P. Tuthill, P. Stewart, E. Huby, G. Perrin, S. Lacour, S. Vievard, N. Murakami, O. Fumika, Y. Minowa, Y. Hayano, J. White, O. Lai, F. Marchis, G. Duchene, T. Kotani, J. Woillez

Proc. SPIE 9147, Ground-based & Airborne Instrumentation for Astronomy V, 91471Q, doi:10.1117/12.2057249, July 2014.

- "Recent progress on phase-mask coronagraphy based on photonic-crystal technology"
  N. Murakami; J. Nishikawa; M. Tamura; E. Serabyn; W. A. Traub; K. M. Liewer; D. C. Moody; J. T. Trauger; O. Guyon; F. Martinache; N. Jovanovic; **G. Singh**; F. Oshiyama; H. Shoji; M. Sakamoto, S. Hamaguchi; K. Oka; N. Baba
  Proc. SPIE 9143, Optical, Infrared, and Millimeter Wave, 914334, doi: 10.1117/ 12.2054790, August 2014.

- "On-sky speckle nulling with the Subaru Coronagraphic Extreme AO (SCExAO) instrument"
  Martinache, F., Guyon, O., Jovanovic, N., Clergeon, C., **Singh, G.**, Kudo, T.
  Proc. SPIE 9148, Adaptive Optics Systems IV, id. 914821, August 2014.

- "SCExAO: First Results and On-Sky Performance
  Thayne, C., Guyon, O., Martinache,F., Clergeon, C., Mi Jovanovic, N., **Singh, G.**, Kudo, T.

- "Lyot-based Ultra-Fine Pointing Control System for Phase Mask Coronagraphs"
  Singh, G., Martinache, F., Baudoz, P., Guyon, O., Matsuo, T., Clergeon, C.
  Proc. of AO4ELT3, DOI: 10.12839/AO4ELT3.12667, 2013

- "SCExAO as a precursor to an ELT exoplanet direct imaging instrument"
  Jovanovic, N., Guyon, O., Martinache, F., Clergeon, C., **Singh, G.**
  Proc. of AO4ELT3, DOI: 10.12839/AO4ELT3.13396, 2013

- 'The Subaru Coronagraphic Extreme Adaptive Optics Imager: First Results and On-Sky Performance"
  Thayne, C., Guyon, O., Martinache, F., Clergeon, C., McElwain, M., Thalmann, C., Jovanovic, N., **Singh, G.**, Kudo,T.
  Proceedings of the International Astronomical Union, 8(S299):34-35, 2013.